4.4 INTERSITE TRANSPORTATION OF FISSILE MATERIALS

For the storage and disposition alternatives, intersite transportation is the transport between sites with fissile and other radioactive materials (including waste) in truckload shipments by DOE SST or commercial conveyance. For overseas shipments of Pu to European fuel fabricators, port handling and ocean transport is included. [Text deleted.] Supporting analyses and information are contained in Appendix G. Intrasite transportation of pits between Zone 4 and Zone 12 at Pantex to support storage of RFETS pits for the Preferred Alternative is described in Appendix Q.

4.4.1 METHODOLOGY

The analysis for the storage and disposition alternatives evaluates the potential risks from transporting shippable forms of fissile materials (Pu and HEU) that have been stabilized and packaged for shipment at the originating site to meet DOT, NRC, and DOE requirements. Baseline information, the existing transportation serving each site, and the types of containers required for shipment of the materials are included in the analysis, as appropriate.

Actual and projected inventories provided by DOE were used for the transportation risk analysis. The health impacts from the transport of materials were estimated using an assumed homogeneous population along specific routes when sites were known, or along an assumed route distribution of 84 percent rural, 15 percent suburban, and 1 percent urban for generic sites; average container, truckload, or rail carload of material; and a unit measure for traffic fatalities (the risk per kilometer). The assessment provides the total potential fatalities over the life of the project for a comparison of transportation impacts for the alternatives considered.

The analysis to estimate health risks in terms of potential total fatalities due to transportation of fissile materials between the sites is accomplished by the method best suited for the alternative. The RADTRAN Version 4 computer code, developed and maintained by SNL at Albuquerque, NM, was used to estimate radiological health risks (SNL 1992b). Unit risk factors were developed for each type of material to estimate the potential risk of transporting truckload shipments by SST over intersite routes. These unit risk factors were used, in conjunction with distance and the number of shipments, to estimate potential radiological and nonradiological (from air pollution and highway accidents) impacts to transport crew members and the public. Transportation impacts, in terms of total potential fatalities, were calculated using the RADTRAN computer code with the projected inventories of fissile materials and their form (nuclide composition), under each alternative considered, and based on nearest routing between sites. Fatalities from potential air pollution were estimated using 1.0×10^{-7} cancer fatalities per urban kilometer. Highway accidents fatalities were estimated from national statistics using 1.5×10^{-8} rural, 3.7×10^{-9} suburban, and 2.1×10^{-9} urban for occupational risks per km, and 5.3×10^{-8} rural, 1.3×10^{-9} suburban, and 7.5×10^{-9} urban for nonoccupational risks per km (SNL 1986a:167). Transportation impacts, in terms of total potential fatalities, were calculated using the RADTRAN computer code with the projected inventories of fissile materials and their form (nuclide composition), under each alternative considered, and based on best direct routing between sites. The transportation accident model in RADTRAN assigns accident probabilities to a set of accident categories. For the truck analysis, the eight accident-severity categories defined in NRC's *Final Environmental Impact Statement on the Transportation of Radioactive Material by Air and Other Modes* (NUREG-0170, December 1977) were used. The least severe accident category (Category I) represents low magnitude of crush force, accident-impact velocity, fire duration, or puncture-impact speed. The most severe category (Category VIII) represents a large crush force, high accident-impact velocity, long fire duration, and high puncture-impact speed, such as 88-km/hr (55-mph) collision into the side of the vehicle, and a 982 °C (1,800 °F) fire lasting 1.5 hr to produce a release of material. The release fractions for Category VIII accidents were conservatively estimated to be 0.1 for the strictly controlled SST shipments and 1.0 for other shipments.

For facilities without a specific site, a bounding risk was established in order to estimate impacts for distances of 1,000 km (621 mi), 2,000 km (1,243 mi), and 4,000 km (2,486 mi), assuming rural, suburban, and urban population distribution of 84, 15, and 1 percent, respectively. For generic representative sites, no specific highway routes were used in the transportation modeling process; the risks for three representative distances are presented for comparison purposes. Under the European MOX fuel fabrication option, the impacts were assessed for transporting Pu materials from DOE origins (that is, from storage, pit disassembly/conversion site, or Pu conversion site) to placement of the material aboard ship. Port handling risks were estimated and ocean transport impacts (global commons) were calculated from the U.S. port to the European port, using RADTRAN. Environmental analyses of overseas port handling, land transport, and handling at the overseas plant would be the responsibility of the European fuel fabrication recipient. The impacts from ocean transport of MOX fuel back to the United States and truck transport from the port to a reactor or storage site were also calculated. The potential health impacts are presented as bounding values equal to the maximum potential risk for both accident and accident-free scenarios.

4.4.2 AFFECTED ENVIRONMENT

4.4.2.1 Transportation Procedures and Practices

Congress has mandated uniform laws for the safe transport of hazardous materials. DOT is the principal Federal agency designated by Congress to implement the regulations, ensure compliance, and provide emergency response guidance.

The Department ships hazardous materials, including radioactive materials, in full compliance with Federal laws specifically covering the transport of these hazardous materials (49 CFR 171-178). These laws are applicable to, and cannot be preempted by, individual states. Although not required by law, DOE has a policy of coordinating the transport of certain hazardous materials, such as Pu and HEU, with State officials. The actual routes are classified; however, they are selected to circumvent populated areas, maximize the use of interstate highways, and avoid bad weather. Exceptional precautions are taken to ensure safe transport. Although DOE has experienced traffic accidents related to the interstate transport of radioactive materials, there has never been a traffic accident involving the release of radioactive material causing injury or death. DOE coordinates emergency preparedness plans and responses with involved states.

The safe, secure transportation of special nuclear materials includes special vehicles and special transportation operational procedures. The design of the vehicles and the transportation operating procedures are classified; however, there has never been a failure of this system to provide safe secure transportation during more than 20 years of operation (DOE 1993ff:1-4).

Special nuclear materials, which include Pu and HEU, require extra measures to ensure physical security and protection of the public from radiation during transportation. DOE's Transportation Safeguards Division (TSD), located in Albuquerque, New Mexico, has the responsibility to provide for the transport of these materials. The TSD was established in 1975 and has accumulated over 110 million km (70 million mi) of over-the-road experience with no accidents causing a fatality or release of radioactive material. DOE's transportation vehicle, the SST, is a specially designed part of an 18-wheel tractor-trailer truck that incorporates various deterrents to prevent unauthorized removal of the cargo. It would be difficult to distinguish these trucks from most other semi-trailer trucks operating on the nation's highways. However, there are significant differences. The SST is designed to protect the cargo in the event of an accident through superior structural characteristics and a highly reliable cargo tie down system similar to that used in aircraft. The thermal characteristics of the SST would allow the trailer to be totally engulfed in a fire without incurring damage to the cargo. The tractor-trailers and their escort vehicles are equipped with communications, radiological monitoring, and other equipment, which further enhance en route safety and security.

Armed nuclear materials couriers, who are Federal officers, accompany each shipment containing special nuclear material. These couriers are hand-picked and highly trained in tractor-trailer driving and electronic and communication systems operation, and are authorized by AEA to carry firearms and make arrests in the performance of their duties. They drive the tractor-trailers and escort vehicles and operate the communications and other convoy equipment. The couriers must meet periodic qualification requirements for firearms, physical fitness, and driving proficiency. They also must pass an annual medical examination and are subject to random drug and alcohol testing.

The Department makes every effort to ensure that its convoys travel at safe speeds and do not travel during inclement weather. Should the convoys encounter adverse weather, provisions exist for them to seek secure shelter at previously identified facilities. A liaison program provides State and local law enforcement officers information on what actions to take to assist one of these vehicles should it be involved in an accident. A DOE control center maintains an emergency contact directory of Federal, State, and local response organizations located throughout the contiguous United States. [Text deleted.]

As further described in Appendix G, the vehicles and transport procedures are specifically designed and tested to prevent a radiological release under all credible accident scenarios. In addition, the packaging is designed and tested to prevent releases. DOE requires the use of highly sophisticated Type B packaging, which is designed to prevent the release of contents under all credible transportation accident conditions, for shipments of Pu and HEU. The testing requirements for these packagings are very demanding. For example, the drop test is equivalent to an impact on a hard surface at 322 km/hr (200 mph) without serious damage to the package or release of its radioactive contents. The containers used for shipping Pu and HEU must pass extremely rigid drop, puncture, thermal, and water immersion testing, and secure approval certification by DOT, NRC, and DOE.

4.4.2.2 Site Transportation Interfaces for Hazardous Materials

The existing transportation modes that serve each DOE site under consideration and the links to those modes for the intersite transport of hazardous materials are summarized in Table 4.4.2.2–1. Although hazardous materials could be transported by rail, truck, air, and barge modes, the materials (including hazardous materials) associated with storage and disposition would be transported only by truck and rail. Pu, including MOX fuel, and HEU would be transported exclusively by SST. Immobilized materials, blendstock for MOX fuel fabrication, TRU waste, and LLW would be transported by certified commercial truck carriers. Pu materials immobilized with highly radioactive isotopes would be transported by rail to a repository. Radioactive CsCl capsules would be shipped by commercial carriers or SST depending on the quantity, in accordance with DOE Order 5633.36. For this analysis, shipment by commercial carrier was assumed. There would be no barge or air shipments and, therefore, there would not be any impacts from transportation by these modes.

Table 4.4.2.2–1. Transportation Modes and Comparison Ratings by Site

Site	Onsite Railroad Service	Nearest Interstate Highway (km)	Distance to Airport for Cargo Shipments (km)	Barge Service	Possible Weather Delays[a]	Overall Level of Transport Service
Hanford	Yes	32	15	Yes	Yes	Good
NTS	No	97	105	No	No	Good
INEL	Yes	74	40	No	Yes	Good
Pantex	Yes	23	11	No	Minimal	Outstanding
ORR	Yes	6	61	Yes	Minimal	Good
SRS	Yes	48	32	Yes	Minimal	Good
RFETS	Yes	16	40	No	Yes	Satisfactory
[Text deleted.]						
LANL	No	66	177	No	Yes	Satisfactory

[a] DOE Transportation Safeguards System shipments.
Source: DOE 1991j; LANL 1992a:1; NTS 1992a:3; RFP 1992b:2.

In the *Nuclear Weapons Complex Reconfiguration Site Evaluation Panel Report,* five sites (Hanford, INEL, ORR, Pantex, and SRS) have been given a comparative rating based on the strengths and weaknesses of their transportation services (DOE 1991j:7). For consistency, the rating methodology and evaluation procedures established by the Nuclear Weapons Complex Reconfiguration Site Evaluation Panel were applied to the remaining DOE sites under consideration. Although DOE has experienced traffic accidents related to the intersite transport of radioactive materials, there has never been a traffic accident involving a release of radioactive material causing injury or death during transportation.

The Department's hazardous material (radioactive and nonradioactive) shipments are small compared to the large shipment volume from non-DOE hazardous material transported within the United States. DOT estimates that approximately 3.6 billion t/yr (4.0 billion tons/yr) of regulated hazardous materials are transported and that approximately 500,000 movements of hazardous materials occur each day (PL 101-615, Section 2[1]). There are approximately 2 million annual shipments of radioactive materials involving about 2.8 million packages, which represents about 2 percent of the annual hazardous materials shipments. Most radioactive shipments involve small or moderate quantities of material in relatively small packages. In comparison, the DOE Nuclear Weapons Complex ships about 6,200 radioactive packages (commercial and classified) annually among its sites. DOE's annual shipments of radioactive packages have represented less than 0.3 percent of all radioactive shipments in the United States. Up to a maximum of 603 shipments per year of radioactive material would be generated for any alternative in this PEIS. This is about 0.03 percent as compared to the total of 2 million shipments, although the size of each shipment may be larger than commercial shipments. Information on each site's historical transportation shipment records is included in Appendix G.

[Text deleted.]

4.4.2.3 Packaging

All Pu, HEU, and MOX fuel to be relocated under this PEIS would be packaged in DOT-approved Type B containers and transported by SST. Packaging refers to a container and all accompanying components or materials necessary to perform its containment function. Packagings used by the DOE for hazardous materials shipments are either certified to meet specific performance requirements or built to specifications described in the DOT hazardous materials regulations (49 CFR 171-180). For relatively low-level radioactive materials, strong, tight packagings or DOT specification Type A packagings are used. These packagings are designed to retain their contents under normal transportation conditions. Shipments of more sensitive radioactive materials require use of highly sophisticated Type B packaging, designed and tested to prevent the release of contents under all credible transportation accident conditions. Each Type B packaging must pass four extremely rigid regulatory tests (drop, puncture, thermal, and immersion) that cover essentially 100 percent of the probable and hypothetical accidents involving impact, puncture, fire, and water immersion. It is highly unlikely that all four accident scenarios would occur to the same package, thus the regulatory requirements are conservative.

Special nuclear material (Pu and HEU) and certain other radioactive materials or weapons components require special protection. In addition to meeting the stringent Type B containment and confinement requirements of NRC's 10 CFR 71 and DOT's 49 CFR, packaging for nuclear weapons and components must be certified separately by DOE. The DOE operates the Transportation Safeguards System for the intersite transport of weapons and components, including Pu and HEU. Specially designed SST are utilized to ensure high levels of safety and physical protection. The system for safe secure transport of Pu and HEU is described in Appendix G.

Typical packagings for the materials analyzed in this PEIS are the DOT specification 6M, Type B or equivalent packaging for the shipment of Pu and HEU; the AT-400A or FL, Type B packaging for Pu pits; the Westinghouse model MO-1, Type B packaging for new MOX fuel; the BUSS R-1 cask for CsCl capsules; the TRUPACT for TRU waste; and Type B truck and rail casks for immobilized materials and MOX spent nuclear fuel. Most other radioactive materials would be transported by commercial truck in Type A fissile packagings. As a representation, a typical testing sequence for the 6M, Type B packaging used for the shipment of Pu and HEU is described in Appendix G. Table 4.4.2.3–1 presents a summary of the radioactive materials, packagings, and affected sites analyzed in this PEIS. [Text deleted.]

4.4.2.4 Transportation Routes and Emergency Preparedness Coordination Among Federal, State, and Local Agencies

Federal laws govern the transport of hazardous materials in the United States to ensure the safety of the public and security of the cargo. The DOT is the principal Federal agency designated by Congress to implement the regulations, ensure compliance, and provide emergency response guidance. Transportation of Pu and HEU, MOX fuel, and immobilized Pu radioactive materials covered by this PEIS would be transported through numerous States in full compliance with Federal laws (49 CFR) that are applicable to individual States. The actual routes would be classified; however, they are selected with input from State and local agencies to circumvent populated areas, maximize the use of interstate highways, and avoid adverse weather. The actual routes would not be designated until the time of transport. Exceptional precautions are taken to ensure safe transport. In addition, DOE has a liaison program through which it communicates with law enforcement and public safety agencies throughout the country, making them aware of these shipments and the exceptional precautions being taken to ensure safe transport through their state.

The packaging, vehicles, and transport procedures are specifically designed and tested to prevent a radiological release under all credible accident scenarios. However, if an emergency situation were to occur, Federal, State, and local emergency preparedness officials are trained and prepared to react to such an emergency. The FEMA is responsible for establishing policies for, and coordinating civil emergency management, planning, and interaction with Federal executive agencies that have emergency response functions in the event of a transportation incident. The FEMA coordinates Federal and State participation in developing emergency response plans and is responsible for the development of the interim *Federal Radiological Emergency Response Plan*. This plan is designed to coordinate Federal support to State and local governments, upon request, during the event of a radiological material transportation incident. FEMA also routinely identifies entities at the State and local levels with whom DOE officials should coordinate to ensure emergency preparedness for specific DOE transportation of Pu or HEU. DOE also has access to transportation coordinators in the Local Emergency Planning Councils and Area Planning Contingency Groups which are required to be formed at the regional and local levels under the *Emergency Planning and Community Right-To-Know Act* of 1986. DOE assists in the training of local emergency preparedness officials in how to respond to such emergencies and how to use certain monitoring equipment. FEMA, which runs the National Fire Academy, also conducts civil defense training of local firefighters. Since firefighters are often the first responders to any type of emergency, the FEMA training includes emergency response to radiological incidents.

4.4.3 ENVIRONMENTAL CONSEQUENCES

Weapons-usable fissile materials analyzed in this PEIS would be either dispositioned or placed into long-term storage. [Text deleted.] This section summarizes the health impacts from the intersite transportation of Pu, HEU, MOX fuel, Cs-137, and other radioactive materials, including waste, based on RADTRAN model results. Impacts are presented based on the movements of the total amount of materials considered under each storage and disposition alternative for the life of the project.

Normal operations associated with the storage and disposition of weapons-usable fissile materials could result in the exposure of transportation workers and the general public to toxic chemicals from vehicular emissions and radiation from the transport of radiological feed materials, products, and wastes generated to accomplish various storage and disposition alternatives. During normal operations (that is accident-free transportation), of radioactive and nonradioactive materials (that is, Pu, HEU, CsCl capsules, canisters of immobilized Pu with radionuclides, MOX fuel, spent nuclear fuel, and wastes), the general population living and traveling along the transport route has a risk of exposure to radioactive and non-radioactive materials (that is, a small amount of

Table 4.4.2.3–1. Transportation Summary of Radioactive Materials and Packagings for Alternatives

	Long-Term Storage				Disposition—Common Activities							
	Upgrade[a]	Consolidation	Collocation		Pit Disassembly/Conversion				Pu Conversion			
		Input	Input 1	Input 2	Input	Output 1	Output 2	Output 3	Input	Output 1	Output 2	Output 3
Materials	Pu	Pu	Pu	HEU	Pu	Pu	TRU waste	LLW	Pu	Pu	TRU waste	LLW
Form	Pits, metal, oxide	Pits, metal, oxide	Pits, metal, oxide	Canned sub-assemblies, metal or oxide	Pits	Metal or oxide	Solid	Solid	Metal or oxide	Metal or oxide	Solid	Solid
Quantity per year (kg)	27,000	27,000	27,000	15,080	2,000	2,000	15,000	12,000	1,000	661	35,890	308,162
Quantity per package[b] (kg)	4.5	4.5	4.5	5.2	45	4.5	980	2,200	4.5	4.5	980	2,200
Packages per shipment	35	35	35	35	35	35	3	5	35	35	3	5
Shipments per year	172	172	172	83	13	13	6	2	7	5	13	28
Packages (type)	AT-400A (B), FL (B) and 6M (B)	AT-400A (B), FL (B) and 6M (B)	AT-400A (B), FL (B) and 6M (B)	6M (B)	AT-400A (B) and FL (B)	6M (B)	TRUPACT (B)	Metal box (A)	6M (B)	6M (B)	TRUPACT (B)	Metal box (A)
Potential origins	RFETS LANL	Hanford INEL Pantex SRS RFETS LANL	Hanford INEL Pantex SRS RFETS LANL	Y–12 Plant	Pantex SRS RFETS	Hanford NTS INEL Pantex ORR SRS	Hanford NTS INEL Pantex ORR SRS	Hanford NTS INEL Pantex ORR SRS	Hanford INEL Pantex SRS RFETS LANL	Hanford NTS INEL Pantex ORR SRS	Hanford NTS INEL Pantex ORR SRS	Hanford NTS INEL Pantex ORR SRS
Potential destinations	Hanford INEL Pantex SRS	Hanford NTS INEL Pantex ORR SRS	Hanford NTS INEL Pantex ORR SRS	Hanford NTS INEL Pantex SRS	Hanford NTS INEL Pantex ORR SRS	Lag storage or disposition[c]	WIPP or alternative	LLW disposal site	Hanford NTS INEL Pantex ORR SRS	Lag storage or disposition[c]	WIPP or alternative	LLW disposal site
Mode	SST	SST	SST	SST	SST	SST	Truck	Truck	SST	SST	Truck	Truck

Table 4.4.2.3–1. Transportation Summary of Radioactive Materials and Packagings for Alternatives—Continued

	Immobilization								
	Vitrification			Ceramic Immobilization			Electrometallurgical Treatment		
	Input 1	**Input 2**	**Output**	**Input 1**	**Input 2**	**Output**	**Input 1**	**Input 2**	**Output**
Materials	Pu	Cs	Pu/ Cs glass[d]	Pu	Cs	Pu/Cs/Gd/ ceramic[d]	Pu	Cs	Pu/Cs/ TRU/ ceramic
Form	Metal, oxide, borosilicate glass	Salt	Glass	Metal or oxide	Salt	Disks	Metal or oxide	Salt	Glass-bonded zeolite
Quantity per year (kg)	5,000	64	100,800	5,000	64	42,000	5,000	47	104,000
Quantity per package[b] (kg)	4.5	5.72	1,680 (84 kg Pu)	4.5	5.72	656	4.5	4.71	5,200 (260 kg Pu)
Packages per shipment	35	1	1	35	1	1	35	1	1
Shipments per year	32	12	60	32	12	64	32	10	20
Packages (type)	6M (B)	BUSS cask (B)	Cask (B)	6M 1141 drum (B)	BUSS cask (B)	Cask (B)	6M 1141 drum (B)	BUSS cask (B)	Cask (B)
Potential origins	Current or lag storage site[c]	Hanford	New glass vitrification site	Current or lag storage site[c]	Hanford	Immobilization site	Current or lag storage site[c]	Hanford	INEL
Potential destinations	Immobilization site	Immobilization site	HLW repository	Immobilization site	Immobilization site	HLW repository	INEL	INEL	HLW repository
Mode	SST	Truck or SST	Rail	SST	Truck or SST	Rail	SST	Truck or SST	Rail

Table 4.4.2.3–1. Transportation Summary of Radioactive Materials and Packagings for Alternatives—Continued

	MOX Fuel Fabrication for Reactors			Deep Borehole: Direct Disposition	Deep Borehole: Immobilized Disposition	
	Input 1	**Input 2**	**Output**	**Input**	**Input**	**Output**
Materials	Pu	Uranium	MOX fuel	Pu	Pu	Pu-loaded ceramic coated pellets
Form	Oxide powder	Oxide powder	Reactor fuel bundles	Metal or oxide	Metal or oxide	Pellets
Quantity per year (kg)	3,000	129,600	132,600	5,000	5,000	500,000
Quantity per package[b] (kg)	4.5	2,200	382 (23 Pu, 359 UO_2)	4.5	4.5	510
Packages per shipment	35	5	2	35	35	5
Shipments per year	20	12	174	32	32	197
Packages (type)	6M (B)	Metal box (A)	MO-1 cask (B)	6M 114 l drum (B)	6M 114 l drum (B)	208 l drum (B)
Potential origins	Current or lag storage site[c]	Y–12 Plant	MOX fabrication site	Current or lag storage site[c]	Current or lag storage site[c]	Immobilization site
Potential destinations	MOX fabrication site	MOX fabrication site	Reactors	Deep borehole site	Immobilization site	Deep borehole site
Mode	SST	Truck	SST	SST	SST	Truck

[a] All HEU for this project is assumed to be located at the Y–12 Plant.
[b] Bounding values used for analysis purposes only.
[c] Lag storage is temporary storage at a disposition facility.
[Text deleted.]
[d] HLW could be combined with the immobilized Pu for the Vitrification or Ceramic Immobilization Alternatives.
Source: DOE 1996e; DOE 1996f; LANL 1996b; LLNL 1996a; LLNL 1996b; LLNL 1996c; LLNL 1996d; LLNL 1996e; LLNL 1996h; NT DOE 1996a; PX DOE 1996a.

additional vehicular emissions) from the passing shipments. Transportation workers could be similarly exposed to radioactive and non-radioactive materials. These are examples of causes of potential radiological and nonradiological fatalities resulting from normal transportation operations. Traffic accidents could have impacts to drivers, passengers, or pedestrians similar to any local or interstate traffic accident. In addition, there could be damage resulting in the releases from the hazardous cargo being transported. Appendix G describes the tests that the packages must withstand to be certified for transporting special nuclear materials. However, traffic accidents could theoretically cause radiological fatalities if there were a release of radioactive material as a result of the traffic accident, and nonradiological fatalities from the effects of vehicular crashes. Radiological and nonradiological fatalities resulting from traffic accidents could affect both the general population and the transportation workers.

Since the establishment of TSD in 1975, DOE has accumulated over 70 million miles of over-the-road experience transporting DOE owned cargo with no accidents causing a fatality or release of radioactive material. However, since there is a theoretical chance of fatalities, this PEIS modeled the potential fatalities from radiological effects of transportation (both normal operations and accident situation) and nonradiological effects of transportation (both normal operations and accident situation) for the various storage and disposition alternatives. [Text deleted.] The potential transportation risks, although small, are greatest for nonradiological traffic accidents compared to radiological risks for both normal operations and accident situations. Impacts are based on the total amount and types of materials moved, numbers of shipments, and the distances those shipments would travel.

The following sections present for each alternative the potential radiological and nonradiological fatalities to the general population and transportation workers. Transportation workers include both the driving crews and any transportation workers who load and unload the materials. Only total potential fatalities, which include radiological and nonradiological impacts for routine and accident conditions, are discussed in this section. The majority of the total impact is due to nonradiological accidents (traffic accidents), followed by radiological routine exposure, nonradiological routine exposure (air pollution), and radiological accidents. Radiological accidents typically have about 1 percent of the total fatalities.

4.4.3.1 No Action

Existing facilities would be used for continued which is the baseline case to which the transportation impacts for other alternatives is compared. Under No Action, there would be no transportation of materials as part of the proposed long-term storage and disposition alternatives, thus no transportation risks incurred.

As part of ongoing operations at the DOE sites, fissile materials may require movement and offsite transportation. These actions, however, would be addressed in separate site-specific environmental documentation, as appropriate.

[Text deleted.]

4.4.3.2 Long-Term Storage Alternatives

Upgrade Alternative

Preferred Alternative for Storage

For the Preferred Alternative for storage, all Pu would be shipped from RFETS. The Pu pit material would be shipped from RFETS to Pantex; the non-pit Pu material would be shipped from RFETS to SRS. Shipments from RFETS would begin in 1997. Pits at SRS are strategic reserve and would be stored according to the ROD for the Stockpile Stewardship and Management PEIS. For analysis of intersite transportation impacts of the Preferred Alternative, the only contributors to intersite transportation risks would be the requirement to ship Pu pits from RFETS to Pantex and to ship non-pit Pu from RFETS to SRS. Intrasite transportation between Zone 4 and Zone 12 at Pantex would occur for the Preferred Alternative if pits are stored in Zone 4 before the upgrade facility is available. Analysis of this intrasite transportation is discussed in Appendix Q. HEU and non-RFETS Pu would remain at existing locations so there would be no additional contributors to transportation risks. All HEU is assumed at ORR. All nonsurplus HEU and surplus HEU pending disposition would be stored in upgraded facilities at ORR under the Preferred Alternative. Pu material currently at Hanford, INEL, Pantex, SRS, and LANL would remain onsite pending disposition (or lag storage at the disposition facilities). The impacts in terms of potential fatalities are based on risks from normal (accident-free) operations and from accidents, both radiological and nonradiological operations and accidents. The risks are based on quantities and types of Pu material as well as the distance, routes, and number of SST trips required. Potential fatalities from intersite transportation activities for the Preferred Alternative are summarized in Table 4.4.3.2–1. Nonradiological accidents are the dominant risk for the Preferred Alternative.

Table 4.4.3.2–1. Total Potential Fatalities From Intersite Transportation Activities for the Preferred Alternative for Storage[a]

Material	Ship From	Ship To	Total Potential Fatalities
Pu Pits	RFETS	Pantex	0.00636
Non-Pit Pu	RFETS	SRS	0.0602
Total Transportation Risk			0.0666

[a] Resulting from both radiological and nonradiological risks to the public and workers for the life of the project for both routine and accident conditions.
Source: RADTRAN model results.

Upgrade Without Rocky Flats Environmental Technology Site Plutonium or Los Alamos National Laboratory Plutonium Subalternative

Under this subalternative, four sites are considered for the upgrade of existing Pu storage facilities: Hanford, INEL, Pantex, and SRS. Pu material from RFETS and LANL included in this PEIS would remain at these two sites. HEU would continue to be stored at ORR. For this subalternative there would be no potential fatalities because intersite transportation would not occur.

Upgrade With Rocky Flats Environmental Technology Site Plutonium and Los Alamos National Laboratory Plutonium Subalternative

Under this subalternative, four sites are considered for the upgrade of existing Pu storage facilities: Hanford, INEL, Pantex, and SRS. Pu material from RFETS and LANL included in this PEIS would be transported to one or more of these four sites. HEU would continue to be stored at ORR. The estimated potential impact from transporting the Pu materials from RFETS and LANL to each potential storage site is presented in Table 4.4.3.2–2. In the case where the RFETS and LANL Pu material would be distributed to more than one site for storage, the resulting number of total potential fatalities would be within the range of values, 0.031 to 0.087, shown in Table 4.4.3.2–2, and fatalities per site would be less than the maximum values shown. [Text deleted.] Nonradiological accidents are the dominant risk for the Upgrade With RFETS Pu and LANL Pu Subalternative.

Consolidation Alternative

Under this alternative, weapons-usable Pu would be transported from existing storage sites to one of five potential consolidated storage facilities located at Hanford, NTS, INEL, Pantex, or SRS (ORR is excluded as a Pu-only storage site). The total potential number of fatalities resulting from transporting Pu to each site under the

Table 4.4.3.2–2. Total Potential Fatalities From the Transportation of Rocky Flats Environmental Technology Site Plutonium and Los Alamos National Laboratory Plutonium for the Upgrade Alternative[a]

Candidate Sites[b]	Total Potential Fatalities[c]
Hanford	0.051
INEL	0.032
Pantex	0.031
SRS	0.087

[a] Resulting from both radiological and nonradiological risks to the public and workers for the life of the project for both routine and accident conditions.
[b] Under the Upgrade Alternative, NTS and ORR are not potential storage sites for Pu, and HEU would remain at ORR.
[c] Effect of transporting all Pu from RFETS and LANL covered by this PEIS to one site.
Source: RADTRAN model results.

Consolidation Alternative is shown in Table 4.4.3.2–3. The highest number of potential fatalities, however, would not exceed 0.346, which is based on moving all Pu covered by this PEIS from existing sites to SRS. Nonradiological accidents are the dominant risk for the Consolidation Alternative.

Table 4.4.3.2–3. Total Potential Fatalities From the Transportation of Plutonium for the Consolidation Alternative[a]

Candidate Sites[b]	Potential Fatalities
Hanford	0.272
NTS	0.172
INEL	0.203
Pantex	0.079
SRS	0.346

[a] Resulting from both radiological and nonradiological risks to the public and workers for the life of the project for both routine and accident conditions.
[b] Under this alternative, ORR is not a potential Pu storage site.
Source: RADTRAN model results.

Collocation Alternative

Under this alternative, weapons-usable Pu and HEU would be transported from existing storage sites to one of six potential collocation storage sites at Hanford, NTS, INEL, Pantex, ORR, or SRS. The transportation health effects were calculated individually for each fissile material going to each of the candidate sites, and then summed. The highest number of potential fatalities, however, would not exceed 1.070, which is based on moving all material to Hanford. The total potential number of fatalities resulting from transporting Pu and HEU under the Collocation Alternative are summarized in Table 4.4.3.2–4. Nonradiological accidents are the dominant risk for the Collocation Alternative.

For both the Consolidation and Collocation Alternatives, all the weapons-usable Pu stored at RFETS and surplus Pu materials currently stored at LANL are included in the analyses for intersite transportation. [Text deleted.]

Table 4.4.3.2–4. Total Potential Fatalities From the Transportation of Plutonium and Highly Enriched Uranium for the Collocation Alternative[a]

Candidate Sites	Potential Fatalities
Hanford	1.070
NTS	0.829
INEL	0.873
Pantex	0.458
ORR	0.285
SRS	0.495

[a] Resulting from both radiological and nonradiological risks to the public and workers for the life of the project for both routine and accident conditions.

Source: RADTRAN model results.

Phaseout

If a site is selected for phaseout, the total potential fatalities impacts of relocating excess Pu or HEU to other DOE sites would be similar to the impacts calculated under the storage and disposition alternatives. [Text deleted.]

Subalternative Not Including Strategic Reserve and Weapons Research and Development Materials

For each of the long-term storage alternatives where the strategic reserve and weapons R&D is not included as part of this program, the transportation health risks associated with the remaining fissile materials has been proportionally estimated from the risks calculated for the entire inventory. Since less material would be moved, the overall result would be potentially fewer fatalities for each alternative. Most of the material is surplus and therefore the reduction would be less than one half of the total fatalities with the strategic reserve.

4.4.3.3 Disposition Alternatives

Alternatives for disposition are intended to permanently prevent certain surplus Pu materials from being used to produce nuclear weapons. The alternative categories are Deep Borehole, Immobilization, and Reactor. Under these disposition alternatives, it is assumed that the surplus fissile materials have been placed in storable forms, suitable for shipment, at the facility of origin.

For the disposition alternatives, the following would apply:

- Almost all surplus Pu pits are located at Pantex, with a limited quantity at RFETS. Pu pits would be transported from existing storage, primarily at Pantex, to potential pit disassembly/conversion sites (unless pit disassembly/conversion is located at the existing storage site). For transportation analysis purposes, pit disassembly/conversion is assumed to be located at one of the following sites: Hanford, NTS, INEL, Pantex, ORR, or SRS, and all pits would be transported from Pantex.

- Non-pit Pu material would be transported from existing storage to a Pu conversion site. For transportation risk analysis purposes, it is assumed that the Pu conversion function would be located at one of six sites: Hanford, NTS, INEL, Pantex, ORR, or SRS. The material would be in a form suitable for shipment in compliance with DOT regulations (49 CFR).

- Surplus Pu at RFETS and at LANL is also being considered for disposition, therefore, is included in the intersite transportation analysis. RFETS and LANL are not being considered for any disposition functions, such as pit disassembly/conversion or immobilization of materials.

- For the disposition actions, the transport of surplus Pu would always originate at either the existing storage sites (Hanford, INEL, Pantex, SRS, RFETS, and LANL) or at the potential pit disassembly/conversion or Pu conversion site (Hanford, NTS, INEL, Pantex, ORR, or SRS).

Table 4.4.3.3–1 presents the total potential health impact from the transportation of Pu from existing storage sites to pit disassembly/conversion or Pu conversion sites. Included in the impact is the effect from the transport of LLW and TRU waste generated. Nonradiological accidents are the dominant risk for both the pit disassembly/conversion and Pu conversion alternatives.

Table 4.4.3.3–1. Total Potential Fatalities From the Transportation of Plutonium From Existing Storage Sites to a Pit Disassembly/Conversion or Plutonium Conversion Site[a]

Sites Analyzed	Pit Disassembly/ Conversion	Pu Conversion
Hanford	0.203	0.455
NTS	0.107	0.211
INEL	0.155	0.340
Pantex	0.033	0.293
ORR	0.155	0.557
SRS	0.190	0.635

[a] Includes effect from the transport of Pu, LLW, and TRU waste from both radiological and nonradiological risks to the public and workers for the life of the project for both routine and accident conditions.

Source: RADTRAN model results.

[Text deleted.]

The total potential fatalities presented in Table 4.4.3.3–1 are based on transporting 30 t (33.1 tons) of pits to the pit disassembly/conversion site and 20 t (22 tons) of Pu to the Pu conversion site. Should the amount of material be less than these amounts, the risk would be lower than these values.

Deep Borehole

Under the deep borehole category, surplus weapons-usable Pu would be in one of two forms: (1) containers of stabilized Pu would be directly emplaced in a borehole and (2) Pu-loaded, ceramic-coated pellets would be emplaced in a borehole. This category of alternatives requires surplus Pu to be transported from lag storage to the borehole site, or to an immobilization site and then to the borehole site. A specific borehole site has not been selected; therefore, for transportation analysis purposes, generic distances of 1,000, 2,000, and 4,000 km (621, 1,243, and 2,486 mi) were used. The amount of Pu to be transported is estimated to not exceed 5 t (5.5 tons) per year.

Under the Direct Disposition Alternative, Pu material would be packaged in 2.25-kg (5-lb) lots (in metal or oxide form) in metal cans at the pit disassembly/conversion site or Pu conversion site. Two cans of Pu (4.5 kg [10 lb]) would be placed into each DOT-specification 2R inner container, which, in turn, would be placed in DOT specification 6M, Type B packaging and shipped by SST to the borehole site. Each shipment (truckload) would contain 35 packages. There would be a total of 32 shipments per year. The shipping containers would be placed directly into metal emplacement canisters at the borehole site without additional handling of Pu material.

Under the Immobilized Disposition Alternative, Pu material would be packaged in 2.25-kg (5-lb) lots (in metal or oxide form) in metal cans, as described above. Two cans would be placed into each DOT-specification 6M, Type B packaging and shipped to a ceramic immobilization facility. There, the material would be converted into Pu-loaded, ceramic-coated pellets (1-percent Pu). The Pu-loaded, ceramic-coated pellets would be shipped in Type B, 208-l (55-gal) drum packaging by SST or commercial truck to the deep borehole site. An estimated 500 t (551 tons) of Pu-loaded, ceramic-coated pellets would be transported per year. This would consist of transporting 510 kg (1,124 lb) of material per Type B package, five packages per SST or commercial truckload shipment, and 981 packages or 197 shipments per year.

The total potential number of fatalities resulting from the transportation of Pu for each of the deep borehole alternatives are shown in Table 4.4.3.3–2. These risks include: (1) the transport of material directly to a deep borehole site, and (2) the transport of material to an immobilization site and then the transport of ceramic pellets from the immobilization site to a deep borehole site. The impacts in Table 4.4.3.3–2 also include the maximum health effect from transporting Pu from existing storage to a pit disassembly/conversion site or Pu conversion site, as derived from Table 4.4.3.3–1. Nonradiological accidents are the dominant risk for the Deep Borehole Category of Alternatives. To calculate the maximum impacts in Table 4.4.3.3–2, 5 t (5.5 tons) of Pu would be transported annually from the farthest lag storage site.

Table 4.4.3.3–2. Total Potential Fatalities From the Transportation of Plutonium and Immobilized Materials for the Deep Borehole Category of Alternatives[a]

Alternative	Sites Analyzed	Total Potential Fatalities[b]
Direct Disposition	No immobilization	1.18
Immobilized Disposition	Hanford	1.95
	NTS	1.62
	INEL	1.79
	Pantex	1.62
	ORR	2.01
	SRS	2.12

[a] Resulting from both radiological and nonradiological risks to the public and workers for the life of the project for both routine and accident conditions.

[b] Based on a distance of 4,000 km to a deep borehole site.

Source: RADTRAN model results.

Immobilization

Under the immobilization category, surplus Pu (in metal or oxide form) would be transported to one of six sites analyzed (Hanford, NTS, INEL, Pantex, ORR, or SRS). Regardless of the site or immobilization technology selected, the amount of Pu to be transported is estimated to not exceed 5 t (5.5 tons) per year.

It is estimated that for 5 t (5.5 tons) of Pu, 35 6M Type B packages would be shipped in each of 32 SST truckloads per year (a total of 1,111 6M packages per year). If the surplus Pu is immobilized with Cs-137, approximately 64 kg (141 lb) of CsCl capsules per year, in approximately 12 BUSS R-1 casks, would require shipment from Hanford to the immobilization site.

The immobilized Pu would be transported in NRC-certified packagings to the HLW repository program in one of two alternative forms; these are:[1]

- **Plutonium, Cesium, and Gadolinium in Vitrified Glass Logs.** Under the Vitrification Alternative, an estimated 101 t (111 tons) of material would be transported per year. This would consist of transporting approximately 1,680 kg (3,704 lb) of material (including 84 kg [185 lb] of Pu and

[1] A variant for both vitrification and ceramic immobilization is to use HLW in place of Cs-137. Use of this material for either alternative would have less total fatalities since HLW would be resident at the site already.

2.1 kg [4.6 lb] of Cs-137) per rail cask, 1 cask per rail shipment, and 60 casks or 60 shipments per year.

- **Plutonium, Cesium, and Gadolinium in Ceramic Disks.** Under the Ceramic Immobilization Alternative, an estimated 42 t (46 tons) of material would be transported per year. This would consist of transporting 656 kg (1,446 lb) of material per rail cask, one cask per rail shipment, and 64 casks or 64 shipments per year.

The total potential fatalities for the transportation of Cs-137 from Hanford to each of the immobilization sites analyzed would range from 0.024 to 0.086. If HLW is used for either the Vitrification or Ceramic Immobilization Alternative there would be 0 total potential fatalities because only HLW onsite where the facility is located would be used. For calculating transportation risks, the representative HLW repository site is assumed at Yucca Mountain, Nevada, for reasons described in Appendix H.

A summary of the maximum health effects from transportation of radiological materials under the immobilization alternative category is presented in Table 4.4.3.3–3. Impacts include the maximum health effects from transporting Pu from existing storage to a pit disassembly/conversion site or Pu conversion site. To calculate the impacts, 5 t (5.5 tons) of Pu would be transported annually from the lag storage[2] site farthest from each of the immobilization sites. Nonradiological accidents are the dominant risk for the Immobilization Category of Alternatives. Under the Preferred Alternative, for analysis purposes, 30 percent of the surplus Pu would be sent to the Pu conversion facility and then either to the vitrification or ceramic immobilization facility. Accordingly, the total potential fatalities for the Preferred Alternative would be lower than those shown in Table 4.4.3.3–3.

Table 4.4.3.3–3. Total Potential Fatalities From the Transportation of Plutonium and Immobilized Materials for the Immobilization Category of Alternatives[a]

	Sites Analyzed					
Alternative	**Hanford**	**NTS**	**INEL**	**Pantex**	**ORR**	**SRS**
Vitrification	0.96	0.49	0.75	0.70	1.25	1.40
Ceramic Immobilization	0.98	0.50	0.77	0.72	1.28	1.43

[a] The analysis assumed that the pit disassembly/conversion and Pu conversion would be collocated at the immobilization site. The analysis includes effect of transporting Cs-137 from Hanford to the immobilization site and the transportation of immobilized materials to a HLW repository site, resulting from both radiological and nonradiological risks to the public and workers for the life of the project for both routine and accident conditions.

Note: Under the Preferred Alternative, for analysis purposes, 30 percent of the surplus Pu would be sent to the Pu conversion facility and then either to the vitrification or ceramic immobilization facility. Accordingly, the total potential fatalities for the Preferred Alternative would be lower than those shown in this table.

Source: RADTRAN model results.

Another immobilization alternative analyzed is electrometallurgical treatment. ANL-W has been analyzed as the representative site, although electrometallurgical treatment could be performed at any site and would give different transportation impacts. Under this alternative, using ANL-W as the representative site, all surplus Pu (in metal or oxide form) would be transported from SRS (the bounding site) to ANL-W located at INEL where it would be immobilized with spent nuclear fuel and Cs-137 at an electrometallurgical treatment facility to produce glass-bonded zeolite, vitrified in canisters as waste. Canisters of GBZ would then be shipped to a HLW repository program. The annual amount of Pu feed material for this process would be identical to that required for the other immobilization processes described above. Approximately 5 t (5.5 tons) of Pu (1,111 packages, 35 packages per SST, 32 SST loads) would be required per year. Pu would be shipped to INEL in DOT-approved 6M, Type B packaging (using 2R inner containers) with approximately 4.5 kg (10 lb) of Pu per package. For the

[2] Lag storage is temporary storage at a disposition facility.

transport of Cs-137 feed material from Hanford, approximately 64 kg/yr (141 lb/yr) of Cs-137, consisting of one rail cask per shipment, 10 shipments per year, would be required. To transport an estimated 104,000 kg/yr (229,278 lb/yr) of GBZ to a repository by rail would require approximately 20 shipments per year, each shipment consisting of one cask (20 casks/yr), or approximately 200 shipments (200 casks) over the 10-year life of the project. This assumes a repository is available and the shipments are made during the 10-year glass bonding production period; otherwise, the immobilized material would be stored onsite until the HLW program accepts the material. The total potential fatalities resulting from the transport of radioactive materials under this alternative is 0.923.

Mixed Oxide Fuel for Reactors

Surplus Pu (oxide powder) would be transported from the lag storage sites (after pit disassembly/conversion or Pu conversion) to domestic or foreign MOX fuel fabrication plants for blending into MOX nuclear reactor fuel. It is estimated that the maximum amount of Pu oxide to be transported per year from lag storage to a MOX fuel fabrication plant would not exceed 3 t (3.3 tons). For domestic MOX fuel fabrication, approximately 20 SST truckloads, consisting of 35 DOT-specification 6M, 113.6-l (30-gal) packages per SST, would be expected to move to the MOX fuel fabrication site each year. It is estimated that the maximum amount of UO_2 powder to be transported per year would be 130 t (143 tons). Approximately 12 truckloads, consisting of five DOT-specification Type A metal boxes per truckload, would also be transported to the MOX fuel fabrication site each year. Each metal box would contain about 2,200 kg (4,850 lb) of UO_2 material.

After processing the Pu at a domestic MOX fuel fabrication plant, a maximum of 133 t (147 tons) of MOX fuel (PuO_2 and UO_2), in reactor fuel bundles, would be transported in approximately 174 truckloads per year to a commercial reactor site or an approved DOE interim storage site. Each truckload contains approximately 2 packages. The Westinghouse Electric model MO-1 shipping cask (NRC Certificate 9069) is used for this analysis. Each cask would contain approximately 23 kg (51 lb) of PuO_2 and 359 kg (791 lb) of UO_2 with an average of 6-percent Pu. Based on an estimated 3,272 t (3,607 tons) of MOX fuel for the entire MOX fuel project, an estimated total of 4,283 truckloads would be required.

The final destination for the MOX fuel could be any reactor capable of using this fuel. After processing the oxides of Pu and uranium into MOX fuel, the fuel has not met the Spent Fuel Standard. However, Pu in the form of MOX fuel is less weapons-usable and much less susceptible to dispersion into the environment than Pu in the oxidized form prior to MOX fuel fabrication. MOX fuel is less weapons-usable because it would require some chemical processing to reclaim the Pu metal. Still, security measures must be implemented and similar measures are routinely in place in the U.S. domestic nuclear power industry for manufacturing and transporting uranium-based fuel to reactor sites. DOE would ensure that MOX fuel is protected by comparable security measures for point of fabrication through usage in a reactor. MOX fuel is less susceptible to dispersion in the environment because the Pu is contained in a pellet and the pellets are contained in a fuel rod. The structural integrity of the fuel rods make dispersion of even the pellets, much less the Pu inside the pellets, very unlikely. Because MOX fuel is less weapons-usable and less dispersable, after fabrication the MOX fuel would be transported by SST with appropriate security protection as described in Appendix G. To allow for comparison of the reactor alternatives, an estimated risk to transport MOX fuel from a MOX fabrication site to a reactor site within the United States or to the Canadian Border (hypothetical distance of 1,000, 2,000, or 4,000 km [621, 1,243, or 2,486 mi]) was used.

The total health risk impacts from transporting both Pu by SST and uranium oxide by truck to potential MOX fuel fabrication plants (hypothetically located 1,000, 2,000, or 4,000 km [621, 1,243, or 2,486 mi] from origin) and to an ocean terminal (hypothetically located at Sunny Point, NC, approximately 1,000, 2,000, or 4,000 km [621, 1,243, or 2,485 mi] from origin), are given in Table 4.4.3.3–4. For Pu destined for European MOX fabrication plant, the impacts include: transportation to the U.S. port; port handling at the U.S. port; ocean transport to European ports of Barrow, United Kingdom, and Cherbourg, France; ocean transport of MOX fuel back to the United States; and SST transport of MOX fuel from the port to either an existing (commercial) reactor site or storage site in the United States. In selecting transportation routes, including any ports, the safety of the public and security of the cargo are of primary consideration. To ensure these primary considerations are achieved, DOE would evaluate the ports to be used based on a set of criteria that would include adequacy of harbor and dock characteristics to satisfy the Pu container carrying ship requirements; adequacy of facilities for safe receipt, handling, and transhipment of Pu and MOX fuel; overall port security; availability of safe and secure lag storage; adequacy of overland transportation systems from ports to the reactor and from the Pu site(s); availability of a skilled labor force with routine experience in safe and secure handling of hazardous cargo; emergency preparedness status and response capabilities at the port and the nearby communities; quality of intermodal access for truck or rail shipments to and from the port; proximity to the proposed pit disassembly/conversion and reactor sites; local restrictions or regulations on movement of hazardous cargo; absence of significant environmental restrictions for the port; and the size of human population at the ports and along transportation routes. Port handling and global commons risks associated with the European MOX fuel fabrication option are discussed in Appendix G. [Text deleted.] The maximum risk impacts from the transport of Pu oxide, uranium oxide, and MOX fuel under the reactor alternatives are summarized in Table 4.4.3.3–4. Nonradiological accidents are the dominant risk for the Reactor Category of Alternatives. The highest number of total potential fatalities from the transportation of materials from lag storage (after pit disassembly/conversion or Pu conversion) to fuel fabrication and then to a reactor site is 4.16 for MOX fuel fabrication in the United States and a 4,000-km (2,485-mi) representative distance for each segment. The transportation risk for shipping MOX fuel from a domestic fabricator to an existing LWR is approximately the same as the transportation risk for shipping uranium-based fuel from a domestic fabricator to an existing LWR. Since the MOX fuel replaces the uranium-based fuel, the incremental transportation risk for the Existing LWR Alternative is only the risk of shipping the oxides to the MOX fuel fabrication site. Assuming a 4,000-km (2,485-mi) representative distance for each segment, the total potential facilities is 0.55. As shown in Table 4.4.3.3–4, using MOX fuel fabricated abroad would increase the transportation risk for this alternative. Under the Preferred Alternative, for analysis purposes, 70 percent of the surplus Pu would be sent to the pit disassembly/conversion facility and then to the MOX Fuel Fabrication Facility. Accordingly, the total potential fatalities for the Preferred Alternative would be lower than those shown in Table 4.4.3.3–4.

Reactor facilities are designed to accommodate spent nuclear fuel onsite, as described under waste management. The impacts of the future transport of DOE spent nuclear fuel, including both incident-free and accident conditions, are addressed in the DOE *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE/EIS-0203-F). That EIS concluded that the estimated number of fatalities from the operation of DOE spent nuclear fuel management facilities would not exceed 0.065 fatalities per year for transportation. Because the dominant risk in transporting radiological materials is nonradiological accidents, the fatalities from the transportation of spent LEU fuel assemblies will be similar to the transportation of spent MOX fuel assemblies. For analysis purposes in the Storage and Disposition PEIS, a maximum risk of 0.65 fatalities is used for transporting spent nuclear fuel to an HLW repository during the 10-year reactor operations period. This maximum risk for transportation of spent nuclear fuel has been added to each MOX total fatalities in Table 4.4.3.3–4.

Summary of Disposition Alternative Transportation Impacts.

A summary of the highest number of potential fatalities for each of the disposition alternatives is presented in Table 4.4.3.3–5. Based on the sites and environmental settings analyzed, none of the alternatives would exceed these values.

Table 4.4.3.3–4. Total Potential Fatalities From the Transportation of Plutonium Oxide, Uranium Oxide, and Mixed Oxide Fuel for the Reactor Category of Alternatives[a]

Representative Distance (km)	From Lag Storage Site to a U.S. MOX Fuel Fabrication Site	From Lag Storage Site to a European Port[b]	From a U.S. MOX Fuel Fabrication Site to a Reactor Site	From a European Port to a U.S. Reactor or Storage Site[b]
Plutonium Oxide				
1,000	0.102	0.132	NA	NA
2,000	0.188	0.218	NA	NA
4,000	0.359	0.389	NA	NA
Uranium Oxide				
1,000	0.060	0.087	NA	NA
2,000	0.104	0.131	NA	NA
4,000	0.193	0.221	NA	NA
Mixed Oxide Fuel				
1,000	NA	NA	1.07	1.47
2,000	NA	NA	1.91	2.31
4,000	NA	NA	3.61	4.01

[a] Resulting from both radiological and nonradiological risks to the public and workers for the life of the project for both routine and accident conditions.

[b] Port handling is evaluated separately as a facility risk. For the Preferred Alternative, the total potential facilities would be less. For analysis purposes, 70 percent of the surplus Pu would be sent to the pit disassembly/conversion facility and then to the MOX Fuel Fabrication Facility.

Note: Under the Preferred Alternative, for analysis purposes, 70 percent of the surplus Pu would be sent to the pit disassembly/conversion facility and then to the MOX fuel fabrication facility. Accordingly, the total potential fatalities for the Preferred Alternative would be lower than those shown in this table. NA=not applicable.

Source: RADTRAN model results.

Table 4.4.3.3–5. Highest Number of Potential Fatalities From the Transportation of Materials for Each Disposition Alternative[a]

Alternative	Highest Number of Potential Fatalities
Deep Borehole	
Direct Disposition	1.18
Immobilized Disposition	2.12
Immobilization	
Vitrification[e]	1.40
Ceramic Immobilization[e]	1.43
Electrometallurgical Treatment	0.923
Reactor	
Existing LWR[e]	5.65[b]
Partially Completed LWR	5.65[c]
Evolutionary LWR	5.65[c]
CANDU Reactor	5.00[d] [e]

[a] Highest potential number of fatalities from both radiological and nonradiological risks to the public and workers for the life of the project for both routine and accident conditions. Includes effects from the transport of Pu from existing storage sites to the pit disassembly/conversion site and Pu conversion site.

[b] Represents total fatalities for transportation with MOX fuel fabricated in the United States, shipped to a reactor in the United States, and the spent fuel shipped to a HLW repository. Because an existing LWR already has LEU fuel shipped to the site and would have spent fuel shipped from the site, the net incremental increase is 1.38 fatalities.

[c] Represents total fatalities for transportation with MOX fuel fabricated in the United States, shipped to a reactor in the United States, and the spent fuel shipped to a HLW repository.

[d] Represents total fatalities for transportation with MOX fuel fabricated in the United States and shipped to the Canadian border and does not include transportation impacts in Canada.

[e] Under the Preferred Alternative, for analysis purposes, approximately 30 percent of the total surplus Pu would be immobilized by either vitrification or ceramic immobilization, and the remaining highest surplus Pu would be used as MOX fuel in existing reactors. Accordingly, the highest number of potential fatalities for the Preferred Alternative would be lower than those for all the Reactor Alternatives.

Source: RADTRAN model results.